failure of shoreline cliffs and bluffs, ultimately protecting existing structures, beaches, upland and bluff top homes, and public utility infrastructure. However, such structures may also have negative impacts on the shoreline environment. They may compound erosion by reducing beach width; steepening offshore gradients; decreasing/disrupting sand supply in areas where seacliff or bluff erosion is a major source of beach sand; disrupting littoral drift; redirecting or impeding ground water and surface water runoff; increasing the scouring action of waves; accelerating erosion on adjacent unprotected properties; and, modifying shoreline erosion patterns and rates.

Rock groin used to limit sand movement along the shore. An effective shore protection device if sand fill is made on the up coast side. Source: Shore Protection in California.

Approximately 12% of California's coastline has some form of armoring.[6] Armoring the coastline (i.e. construction of seawalls, revetments, bulkheads, etc.) can be a factor in eliminating sources of beach sand contributed through bluff erosion. However, bluff erosion is a less significant source of sand when compared to the loss of sand from dammed rivers and streams, particularly in Southern California. Rates of bluff erosion vary greatly from location to location; primarily because of the difference in the material makeup of the bluffs themselves. For example, the granite bluffs found on some areas of the Monterey Peninsula erode at a negligible rate compared to the up to eight feet of erosion that can occur annually in areas of unconsolidated sand dunes such as those found at Pajaro Dunes in Santa Cruz County. Typically the average rate of retreat in sedimentary rocks or sandstone (which is the primary composition of coastal bluffs in Southern California) ranges from a few inches to perhaps a foot in a year. As these bluffs erode, the sand that is created normally accounts for less than 20% of the sand found on any particular beach.

Example of rock jetties protecting a harbor entrance. Source: Shore Protection in California.

There are various types of hard structures that are typically built along California's coastline. The type of structure built depends on the location and its intended purpose (i.e. bank protection, bluff protection, beach building). Generally these structures include groins, breakwaters, rock revetments, seawalls, and seacave fills. Groins (jetties at harbor entrances) are constructed perpendicular to the shoreline to interrupt the migration of sand along a beach. Because of the effects of littoral drift, they typically trap sand on one side and starve the beach on the opposite side. They are normally constructed of rock, reinforced concrete, steel sheet piling, wood planking or a combination thereof. If properly engineered and backfilled with sand, groins can be very effective in limiting the impact of wave erosion on a shoreline. Examples of the success of this type of structure are the beaches in Santa Monica that are roughly 400-600 feet in width today. They were created by the construction of a series of groins perpendicular to the shore and backfilled with sand materials

Offshore breakwater at the Santa Monica Pier. Note buildup of sand behind breakwater.

excavated during the construction of the Hyperion Wastewater Treatment Plant near the Los Angeles International Airport.

Breakwaters are generally installed offshore to provide harbor protection. Breakwaters may have the additional effect of preventing the shoreline from eroding and may result in sand buildup. An example of this is the offshore breakwater constructed in front of the Santa Monica Pier. After construction of this offshore breakwater, the beaches around the foot of the Santa Monica Pier accreted substantially. Generally these types of onshore accretions do not cause any significant loss of sand to downcoast locations once they have stabilized and reached equilibrium.

Example of rock revetment used as shore protection device. Source: Shore Protection in California.

Rock revetments (the onshore version of an offshore breakwater) will generally be constructed at a 2:1-1/2 to 2:1 slope and therefore can extend for some distance out onto the beach.

Seawalls are normally parallel to the shoreline and generally occupy less sandy beach area than other types of structures. Seawalls are usually constructed of reinforced concrete, steel sheet piling or wood planking. Wood planking is the least desirable material in that it has a much greater failure rate than seawalls constructed of either steel sheet piling or reinforced concrete.

Massive sea walls previously constructed in Encinitas. This type of sea wall is no longer typical.

Seacave fills, or bluff notch fills, are located completely within and behind the bluff face and, according to the California Coastal Commission, have less impact on beaches. In northern San Diego County, seacaves or notches form as a result of waves and wave thrown cobble impacting the Torrey Sandstone bluffs. This rapid erosion causes an undercutting on the face of the bluff and can ultimately lead to a catastrophic collapse of the bluff face, undermining public and private structures located on the bluff top. These bluff top structures can be either private residential development, commercial developments or public infrastructure such as roads, water lines, waste water lines, power lines, etc. Because of the nature and location of these structures, most have relatively high monetary value. Loss of private structures impacts state and local government in that it removes high value properties from the tax base and often involves the Federal Emergency Management Agency (FEMA) program.

Current less obtrusive sea walls, notch fills.

Recent seacave fills use a "leaner" cement mix intended to allow the fill to erode at the same rate as the adjacent bluffs. Thus, the fill of seacaves does not result in a loss of beach area otherwise available for public recreational use, and the back of the beach is not permanently fixed in place. The seacave fill will not prevent the erosion of unprotected bluff face material onto the beach since it will not cover any portion of the bluff as a seawall or upper bluff work would. The upper portion of bluffs may continue to erode from natural causes of wind, rain, and surface run off.[7]